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MUNICIPAL AND INDUSTRIAL WATER REQUIRE-
MENTS CYPRESS BAYOU RESERVOIR BOSSIER
PARISH, LOUISIANA

Public Health Service
Dallas, Texas

April 1961

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LOUISIANA

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII

In Cooperation with the

DEPARTMENT OF THE ARMY
U. S. Army Engineer District - New Orleans, Louisiana

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i-2

TABLE OF CONTENTS

	Page
LIST OF TABLES	iii
LIST OF FIGURES	iv
I. INTRODUCTION	
Authority	1
Purpose and Scope	1
Acknowledgments	1
II. SUMMARY AND CONCLUSIONS	
Summary	2
Conclusions	2
III. DESCRIPTION OF PROJECT	
Location	4
Stream Flow	4
Water Quality	4
Pertinent Data	5
IV. DESCRIPTION OF STUDY AREA	
Location and Boundaries	6
Geography	6
Principal Communities	6
V. ECONOMICS AND POPULATION	
Extractive Industries	7
Manufacturing	9
Retail Trade and Service Establishments	9
Population	13
Future Growth	13

TABLE OF CONTENTS (Continued)

	Page
VI. WATER REQUIREMENTS	
Past and Present Water Use	15
Existing Sources	15
Additional Water Needs	18
VII. BENEFITS OF STORAGE	
Evaluation Method	21
Alternative Plan	21
VIII. APPENDIX	
Calculations Used for Alternative Cost Determinations (Alternative A)	EXHIBIT A-1
Calculations Used for Alternative Cost Determinations (Alternative B)	EXHIBIT B
IX. BIBLIOGRAPHY	22

LIST OF TABLES

	Page
Table 1. Stream Flow Data - Cypress Bayou	4
2. Chemical Analysis of Cypress Bayou Water, 1955	5
3. Pertinent Data for the Proposed Cypress Bayou Dam	5
4. Crude Oil and Natural Gas Production, 1954 and 1958	7
5. Value of Mineral Production, 1954 and 1958 . . .	8
6. Timber Severance, Bossier and Caddo Parishes, 1954 and 1956	8
7. Agricultural Statistics for Bossier and Caddo Parishes, 1944, 1949, and 1954	10
8. Employment, Wages, and Output of Manufac- turing, Complex of Louisiana and the Study Area, 1947, 1954, 1958	11
9. Type and Size of Manufacturing Firms, Study Area, 1954	11
10. Retail Trade	12
11. Service Establishments	12
12. Historical Population of the Study Area and Its Components	13
13. Water Consumption Data, Shreveport - Bossier City, Louisiana, Area, 1950 through 1958 . . .	15
14. Characteristics of Cross Lake Water, 1959 . . .	16
15. Chemical Characteristics of Red River Water at Shreveport, Louisiana, 1956, 1957	17
16. Characteristics of Well Water, Benton, Louisiana, June 30, 1953	18

LIST OF FIGURES

	Following Page
Figure 1. Location Plan	4
2. Population Projections	13
3. Projected M & I Water Requirement	19
A-1. Pump Characteristic Curves	EXHIBIT A-5

I. INTRODUCTION

Authority

This report was requested in a letter from the District Engineer, U. S. Army Engineer District, New Orleans, Louisiana, to the Regional Engineer, Region VII, Public Health Service, Dallas, Texas, dated February 11, 1959. The report is written in accordance with the Memorandum of Agreement between the Department of the Army and the Department of Health, Education, and Welfare, dated November 4, 1958, which provides that the latter assist the Department of the Army in implementing the Water Supply Act of 1958.

Purpose and Scope

The primary objective of this report is the determination of the need for water supply storage and its value (benefits) for the study area. Particularly considered is municipal and industrial water storage in the proposed Cypress Bayou Reservoir.

To arrive at these needs, studies are made of the economic and demographic variables. These are then projected to the year 2015, combined with projected water usage, and translated into municipal and industrial water needs.

Acknowledgments

Grateful acknowledgment is made for the assistance and cooperation of the Louisiana State Board of Health; Louisiana Stream Control Commission; United States Geological Survey; District Engineer, U. S. Army Engineer District, New Orleans, Louisiana; Louisiana Department of Public Works; Northwest Regional Development Board, Shreveport, Louisiana; Bossier Chamber of Commerce, Bossier City, Louisiana; the city officials of the cities of Shreveport, Bossier City, and Benton, Louisiana; and others whose assistance resulted in the most expeditious completion of this report.

II. SUMMARY AND CONCLUSIONS

Summary

1. The site of the proposed Cypress Reservoir project is approximately four miles east of the town of Benton, Bossier Parish, Louisiana, on Cypress Bayou.
2. The study area consists of Bossier Parish, Louisiana, and the city of Shreveport in Caddo Parish, Louisiana.
3. The major water users are the municipalities of Shreveport, Bossier City, Benton, and Plain Dealing. Present water sources are deficient in quality rather than quantity except for Shreveport, which has an excellent supply in Cross Lake.
4. There are no industries using large amounts of water in the area, and the majority of the waste flow produced is municipal from the above named cities. Wastes from Shreveport, Bossier City, and Benton are routed to the Red River without treatment, while Plain Dealing discharges its wastes into Cypress Bayou after treatment in an Imhoff tank.
5. The area's population has been projected to 640,000 in 2015, or almost a threefold increase of the 1960 population of 221,065.

Conclusions

1. The city of Shreveport can satisfy its water requirements in 2015 from surface sources west of the Red River. The town of Plain Dealing can augment its existing ground water supply with surface water from the water storage pools of two impoundments being constructed by the Soil Conservation Service of the United States Department of Agriculture. Bossier City and Benton are in need of additional water at this time, due to quality of existing supplies, and this requirement will increase in the future. The municipal and industrial water requirements of Bossier City and Benton are projected as 23.4 mgd in 2015.

2. Municipal and industrial water requirements for 2015 can be satisfied by providing storage in the proposed multipurpose Cypress Bayou Reservoir.
3. The estimated value of storage in Cypress Bayou Reservoir to supply an expected demand of 23.4 mgd is \$86,400 per year or 1.0¢ per 1,000 gallons at site "C," and \$104,200 per year or 1.2¢ per 1,000 gallons at site "A."

III. DESCRIPTION OF PROJECT

Location

The project is located in Bossier Parish, Louisiana, approximately four miles east of the town of Benton as shown in Figure 1. The Bayou has a drainage area of 147 square miles at this point. A second location below the confluence of Black Bayou and Cypress Bayou has been shown to be impractical, since any substantial water storage would result in the flooding of developed areas in and adjacent to the town of Benton.

Stream Flow

Stream flow data on Cypress Bayou consist of miscellaneous U. S. Geological Survey measurements as shown in Table 1 made at the crossing of State Highway 162, three miles east of Benton, Louisiana. The drainage area at this point is 133 square miles.

Table 1 1/

Stream Flow Data - Cypress Bayou

<u>Date</u>	<u>Discharge (cfs)</u>	<u>Date</u>	<u>Discharge (cfs)</u>
November 26, 1947	26.8	December 8, 1954	0.13
August 18, 1954	0	January 13, 1955	16.6
September 21, 1954	0	July 12, 1955	0.02
October 18, 1954	0	August 17, 1955	2.69
November 19, 1954	0	September 19, 1955	0

According to the Louisiana State Department of Public Works, 2/ the mean annual runoff from 106 square miles of watershed is estimated to be 75,000 acre-feet.

Water Quality

The water from Cypress Bayou is considered suitable for municipal use. It is generally low in mineral content and with a modest amount of treatment would become satisfactory in all respects. Table 2 shows an analysis of the water collected by the U. S. Geological Survey in 1955.

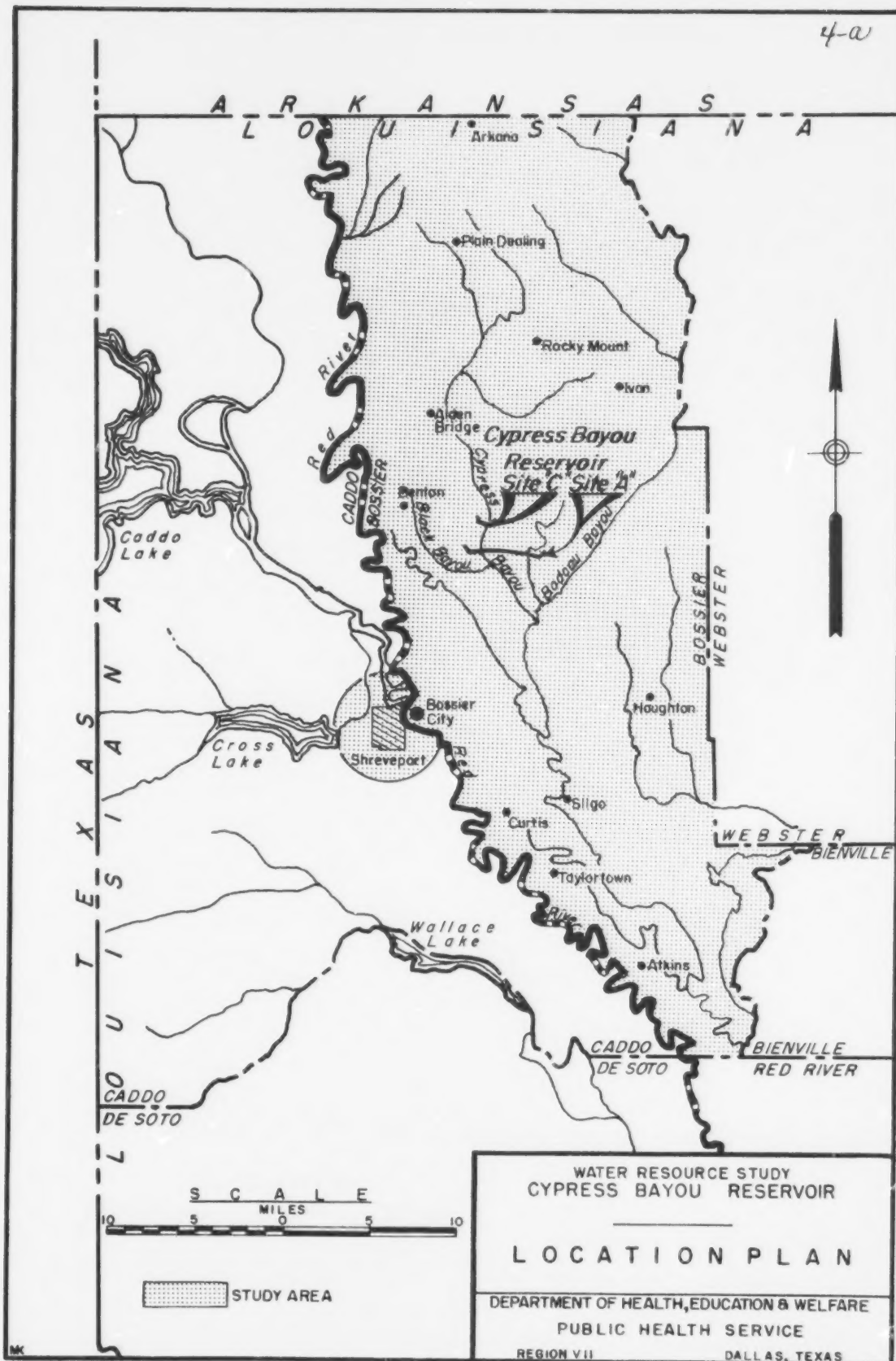


FIGURE 1

Table 2 1/Chemical Analysis of Cypress Bayou Water - 1955*

<u>Item</u>	<u>-----Date-----</u>		
	<u>10-10-55</u>	<u>11-18-55</u>	<u>12-7-55</u>
Mean discharge (cfs)	0.447	0.649	17.4
Silica (SiO ₂)	5.2	15	14
Iron (Fe)	0.92	0.23	0.43
Calcium (Ca)	5.4	4.8	2.5
Magnesium (Mg)	1.6	1.8	0.9
Sodium (Na)	8.3	4.7	8.5
Potassium (K)	2.8	3.4	3.0
Bicarbonate (HCO ₃)	29	24	14
Sulfate (SO ₄)	3.0	2.8	5.5
Chloride (Cl)	10	7.0	10
Fluoride (F)	---	---	---
Nitrate (NO ₃)	0.8	0.5	0.5
Boron (B)	---	---	---
Dissolved Solids	52	52	52
Ca-Mg hardness as CaCO ₃	20	19	10
Noncarbonate hardness as CaCO ₃	0	0	0
Per cent Sodium	43	30	57
Sodium adsorption ratio	0.8	0.5	1.2
Specific Conductance micro-mhos @ 25°C	91.2	72.2	73.8
pH	6.7	6.2	6.1

*All values are in parts per million except as noted.

Pertinent Data

Preliminary pertinent data, as furnished by the Corps of Engineers, are given in Table 3.

Table 3

Pertinent Data
For the Proposed Cypress Bayou Dam

	<u>Site "C"</u>	<u>Site "A"</u>
Drainage Area, sq. mi.	147	175
Downstream Channel Capacity, cfs	670	800
Water Supply Pool (M & I and Irrigation)		
Elevation, ft., m.s.l.	191.7	188.3
Area, acres	4,300	6,400
Storage, acre-feet	50,000	70,000
M & I Yield, mgd	23.4	23.4
Irrigation Yield, acre-feet/yr.	11,873	34,076

IV. DESCRIPTION OF STUDY AREA

Location and Boundaries

The study area, as shown in Figure 1, is confined to Bossier Parish, Louisiana, and the city of Shreveport, Louisiana, in Caddo Parish. A companion report by the Public Health Service on Bayou Dorcheat ¹⁵/ concluded that the future water needs of Webster Parish (to the east) can be met from sources within its own watershed. On the west, the Red River forms a natural boundary in terms of water supply, and Shreveport is the only area west of the Red River considered in the study. Also, the limited capacity of the proposed reservoir restricts its potential service area.

Geography

The drainage area is hilly in the upper reaches and becomes rolling to gently rolling in the vicinity of the dam site.

The study area has a relatively mild climate with a mean temperature of 46.3° F in January and 82.1° F in July. The average annual rainfall is 47.89 inches, and the length of the growing season is 222 days.

Principal Communities

The principal communities of the study area are Shreveport, Bossier City, Benton, and Plain Dealing. This is only a part of the Shreveport Standard Metropolitan Statistical Area, which consists of the whole of Bossier and Caddo Parishes.

V. ECONOMICS AND POPULATION

Extractive Industries

Minerals, especially natural gas and petroleum, are major factors in the economy of the area. The Sabine Uplift, which includes northwest Louisiana, is known to contain approximately one-fifth of the Nation's confirmed oil resources. Table 4 3/ shows the production of petroleum and natural gas for Bossier and Caddo Parishes for the years 1954 and 1958.

Table 4 3/

Crude Oil and Natural Gas Production
1954 and 1958

	<u>Crude Oil (bbls)</u>		<u>Natural Gas</u> <u>Mc.f. @ 15.025 psia</u>	
	<u>1954</u>	<u>1958</u>	<u>1954</u>	<u>1958</u>
Bossier Parish	1,793,211	1,937,681	83,936,710	98,535,243
Caddo Parish	9,435,748	8,218,818	20,416,877	36,798,940

The above shows a slight upward trend in production of both items in Bossier Parish, while Caddo Parish shows a considerable rise in natural gas production and a slight drop in crude oil production. Table 5 4/ shows the value of mineral production for 1954 and 1958 and lists the minerals in order of value.

Table 5 4/

Value of Mineral Production
1954 and 1958

	<u>Value (Dollars)</u>		<u>Minerals in Order of Value</u>
	<u>1954</u>	<u>1958*</u>	
Bossier Parish	18,108,923	26,431,913	Natural Gas, Petroleum, Natural Gas Liquids, Sand and Gravel
Caddo Parish	42,779,245	31,163,870	Petroleum, Natural Gas Liquids, Natural Gas, Sand and Gravel, Clay

*Adjusted to the 1954 value of the dollar.

Table 5 verifies the values shown in Table 4. Since petroleum, its derivatives, and natural gas account for the bulk of mineral production in the area, it is assumed that the reduction in production of these minerals accounts for the decrease in value between 1954 and 1958 in Caddo Parish. Sands, gravels, and clays are relatively plentiful throughout the State. The production of these materials is not very large and is for the most part geared to local needs.

The forest industry is important to the study area's economy. In 1954, the percentage of land area classified as commercial forest was 65.4 per cent in Bossier Parish and 50.9 per cent in Caddo Parish. This is equivalent to 158.5 million cubic feet of growing stock including 490.1 million board feet of saw timber in Bossier Parish, and to 125.4 million cubic feet of growing stock including 339.4 million board feet of saw timber in Caddo Parish. Table 6 5/ shows the timber severance for the years 1954 and 1956.

Table 6 5/

Timber Severance, Bossier and Caddo Parishes
1954 and 1956

	<u>Saw Timber (M.F.B.M.)</u>		<u>Pulpwood (Cords)</u>	
	<u>1954</u>	<u>1956</u>	<u>1954</u>	<u>1956</u>
Bossier Parish	11,090	16,187	46,972	40,324
Caddo Parish	4,227	2,415	22,199	35,474

The climate of the study area affords a long growing season and the soil will support a variety of crops. Cotton, corn, peanuts, soy beans, alfalfa, peaches, wheat, and sweet potatoes are among the commodities produced. Livestock production (both cattle and swine) and the poultry industries are rapidly expanding. Table 7 6/ shows the trend of agriculture between 1944 and 1954. For comparison, monetary values shown have been adjusted to the 1944 dollar base. Table 7 also shows that the number of farms and acres harvested both decreased. On the other hand, the value of crops and livestock and livestock products increased.

Manufacturing

The increase in manufacturing in the study area has influenced the trend toward urbanization. Table 8 7/ shows the size of the manufacturing complex of the study area compared to the whole state. It is clear that the study area has expanded at a greater rate. The number of employees in the study area increased 32 per cent between 1947 and 1958, while the payroll increased 67 per cent during the same period. The value added increased 58 per cent between 1947 and 1958, calculated on a constant dollar base. This item is computed by subtracting the cost of materials from sales price of the output for all firms in the industry.

Table 9 7/ shows the type and size of the manufacturing establishments in the study area in 1954. The diversification of the industrial base is at once apparent. The table indicates that the majority of manufacturers conduct a relatively small operation with only 20 employing over 100; 50 employing between 20 and 99; and 158 employing less than 20 in all of the 16 categories represented. The increase in employment between 1954 and 1958 (Table 8) and the continued increase between 1958 and 1960* indicate a continuation of expansion in the number and size of manufacturing firms in the study area. The manufacturing complex is generally resource oriented.

Retail Trade and Service Establishments

Retail trade can be considered an indicator of an area's prosperity. Table 10 8/ shows the sales volume of the study area and the state growing at approximately the same rate. While the number of establishments has remained relatively constant, the number of employees and the sales volume have both increased, indicating a size increase in the establishments.

*Louisiana State Employment Service, Labor Market Trends, January - September, 1960.

Table 7 6/

Agricultural Statistics for Bossier and Caddo Parishes
1944, 1949, and 1954

<u>Item</u>	-----Bossier Parish-----			-----Caddo Parish-----		
	<u>1944</u>	<u>1949</u>	<u>1954</u>	<u>1944</u>	<u>1949</u>	<u>1954</u>
Number of Farms	2,280	2,018	2,020	4,534	3,400	2,771
Acres Harvested	68,882	60,014	57,691	101,259	95,949	79,897
Value of Crops Sold (\$)	2,526,500	3,669,250	3,220,406	4,064,438	6,467,886	5,590,504
Value of Livestock and Livestock Products Sold (\$)	512,722	505,335	965,452	1,100,431	1,151,432	1,392,659

Table 8 7/

Employment, Wages, and Output of Manufacturing
Complex of Louisiana and the Study Area
1947, 1954, 1958

	<u>Number of Employees</u>	<u>Payroll of Employees (\$1,000)*</u>	<u>Value Added (\$1,000)*</u>
<u>1947</u>			
Louisiana	132,463	309,869	694,062
Study Area	5,776	12,294	24,290
<u>1954</u>			
Louisiana	144,757	531,639	1,032,761
Study Area	6,439	21,512	45,075
<u>1958</u>			
Louisiana	137,100	621,700	1,148,677
Study Area	8,455	37,368	57,854

*Adjusted to the 1947 value of the dollar.

Table 9 7/

Type and Size of Manufacturing Firms
Study Area, 1954

	<u>Number of Employees</u>		
	<u>1-19</u>	<u>20-99</u>	<u>100 & over</u>
Food and kindred products	38	11	7
Apparel and related products	3	--	1
Lumber and wood products	30	10	3
Furniture and fixtures	7	1	--
Pulp, paper and products	--	1	--
Printing and publishing	20	2	1
Chemicals and products	8	8	1
Petroleum and coal products	--	4	2
Stone, clay & glass products	10	2	1
Primary metal industrial	5	--	1
Fabricated metal products	11	4	1
Machinery, except electrical	10	4	1
Electrical machinery	3	--	--
Transportation equipment	2	2	--
Instruments & related products	2	--	--
Miscellaneous manufacturers	9	1	1

Table 10 8/Retail Trade

	<u>Number of Establishments</u>	<u>Number of Employees</u>	<u>Sales Volume (\$1,000)*</u>
<u>1948</u>			
Louisiana	29,693	98,702	1,681,334
Study Area	1,644	9,820	171,910
<u>1954</u>			
Louisiana	26,845	107,833	2,094,833
Study Area	1,932	11,456	207,843
<u>1958</u>			
Louisiana	28,008	119,592	2,347,351
Study Area	1,942	11,929	223,524

*Adjusted to the 1948 value of the dollar.

Wholesale trade generally followed the trend of retail trade and is not tabulated herein.

Service establishments such as hotels, personal services, automobile repair services, motion pictures, other amusements, and miscellaneous repair services showed considerable growth between 1948 and 1954, being still another indicator of the trend toward urbanization. Table 11 8/ illustrates this growth with the dollar adjusted to the 1948 value.

Table 11 8/Service Establishments

	<u>Number of Establishments</u>	<u>Number of Employees</u>	<u>Sales Volume (\$1,000)*</u>
<u>1948</u>			
Louisiana	6,692	18,479	90,866
Study Area	538	2,739	12,097
<u>1954</u>			
Louisiana	10,009	33,137	247,832
Study Area	938	4,351	25,813

*Adjusted to the 1948 value of the dollar.

Population

The population of the study area has increased rather steadily since 1910 as shown in Figure 2. Table 12 9/ shows the historical population for the study area and its components. The trend toward urbanization is evidenced by the increase in the ratio of urban to total population -- from 56.4 per cent in 1910 to 88.0 per cent in 1960.

Table 12 9/

Historical Population of the Study Area And Its Components

<u>Place</u>	<u>Population in Thousands</u>					
	<u>1910</u>	<u>1920</u>	<u>1930</u>	<u>1940</u>	<u>1950</u>	<u>1960</u>
Benton, La.	0.3	----	0.4	0.5	0.7	1.3
Bossier City, La.	0.8	1.1	4.0	5.8	15.5	32.7
Bossier Parish, La.	21.7	22.3	28.4	33.2	40.1	57.4
Shreveport, La.	28.1	43.8	76.6	98.1	127.2	163.7
Study Area	49.8	66.1	105.0	131.3	167.3	227.1

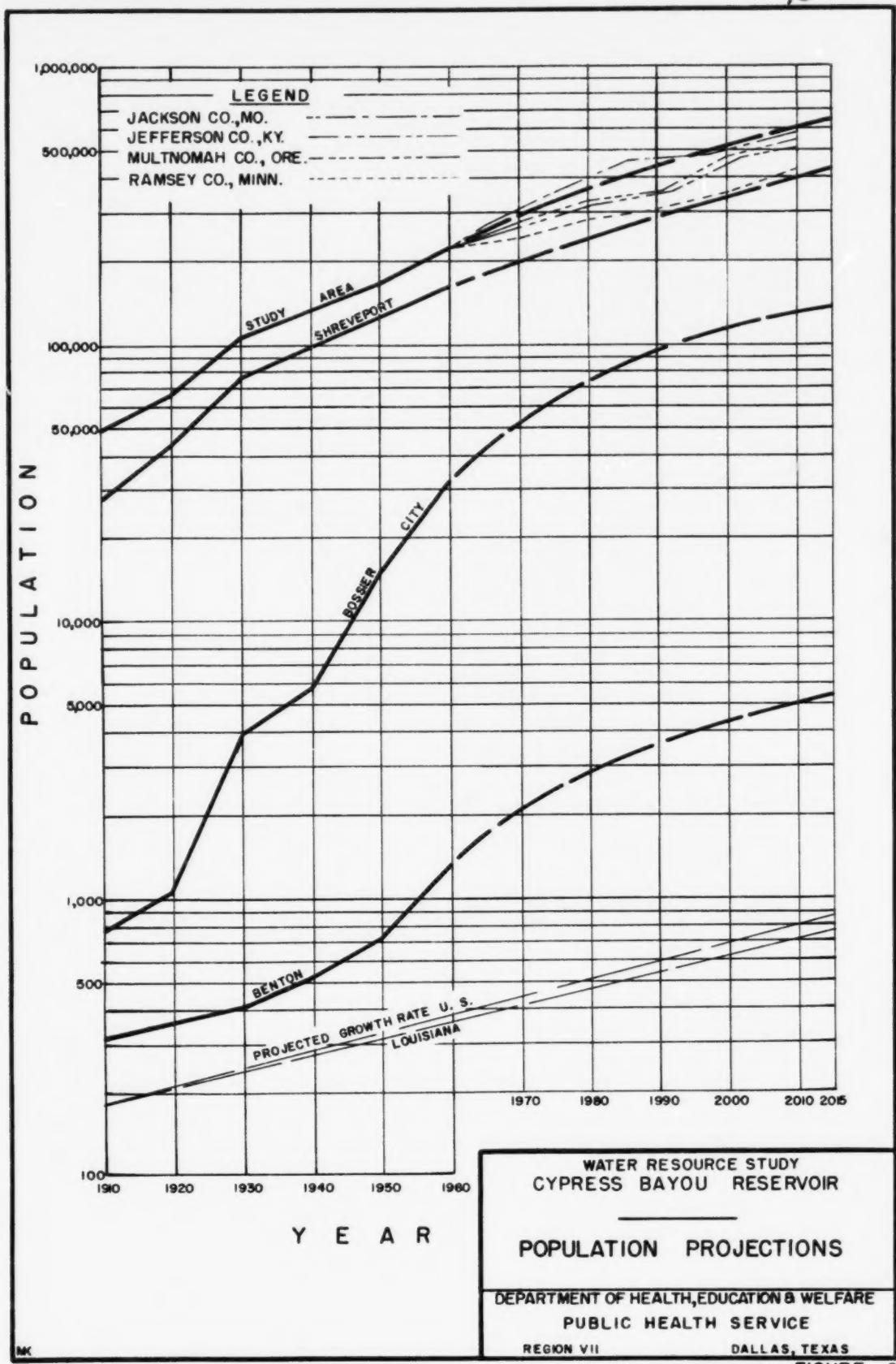
Future Growth

The population of the Nation is projected to grow at 1.5 per cent per year, which means that the population will double in 47 years. An increase in the demand for goods and services is expected to more than parallel this growth. It follows, therefore, that the area more capable of providing these goods and services has the greater possibility of future growth and expansion.

Reserves of natural gas and oil previously mentioned are large, and until atomic power or some fuel as yet unknown comes into general use, the demand for these resources will continue to increase. Agricultural production of fiber, corn, and feed is expected to expand with the population; and new, more efficient farming methods should result in a higher rate of production on available land. The forest products industry will continue to be very important to the economy of the study area, which supplies a rapidly expanding pulp and paper industry.

The area is well provided with air, rail, and highway transportation geared to grow as the need arises. These facilities, coupled with the area's geographic location, resources, and nearby market, will encourage manufacturing expansion in the future.

13-a



An abundance of power and fuel are available. Natural gas provides a readily available, inexpensive and efficient fuel supply. Proved reserves of natural gas are now estimated to last approximately 17 years at present production rates. However, when consideration is given to the rate at which the proved reserves have been increasing, it may be conservatively assumed that natural gas will remain the chief fuel of the study area throughout the 50-year period from the year 1965 until the year 2015. Electric power is produced from natural gas through steam generation and its availability will parallel that of its parent fuel.

Favorable climate and a potentially abundant water supply add to the attractiveness of the area and increase its possibilities of future growth.

Figure 2 shows the projected 2015 population of the area to be 640,000 persons. This is an increase of 190 per cent. The projection is based on comparison with (1) other areas similar in nature, (2) projected growth rates of the United States and the state of Louisiana, and (3) the area's own historical growth.

VI. WATER REQUIREMENTS

Past and Present Water Use

The data in Table 13 10/ show the water use for the Shreveport-Bossier City area for the years from 1950 through 1958. Barksdale Air Force Base obtains its water from the city of Shreveport. Water use for the installation is shown in a separate column and is not included in the per capita consumption column. Figures for raw water shown in Table 13 are adjusted upward 10 per cent from plant pumpage amounts to account for treatment plant attenuation.

The data are incomplete after 1958, as Bossier City began operation of its own water facility on the Red River. The town of Benton uses approximately 75 gallons per capita per day from its underground supply.

Table 13 10/

Water Consumption Data
Shreveport - Bossier City, Louisiana Area
1950 through 1958

<u>Year</u>	<u>Avg. Raw Water Use (mgd)</u>	<u>Barksdale AFB Average Use (mgd)</u>	<u>Shreveport- Bossier City Average Use (mgd)</u>	<u>Estimated Population Served (1,000)</u>	<u>Shreveport- Bossier City (gpcd)</u>
1950	15.75	1.08	14.67	142.7	103
1951	18.83	1.32	17.51	148.0	118
1952	19.74	1.32	18.42	153.4	120
1953	21.15	1.42	19.73	158.8	124
1954	21.92	1.41	20.51	164.1	125
1955	21.30	1.41	19.89	169.5	117
1956	24.65	1.46	23.19	174.9	133
1957	21.93	1.36	20.57	180.3	114
1958	22.20	1.25	21.45	185.6	116

Existing Sources

The city of Shreveport obtains its water from Cross Lake, which has a storage capacity of 30 billion gallons. This source is augmented by water from Twelve Mile Bayou, which drains Caddo Lake. Two pumps with a total rated capacity of 50 mgd lift the water from Twelve Mile Bayou via a 60-inch main to Cross Lake.

Cross Lake was originally developed as a water supply by the city of Shreveport in the year 1926, when the peak chlorides content of the Red River, its source until that time, reached 1,160 ppm making it unsatisfactory for further use as a municipal supply. Table 14 ^{12/} shows the characteristics of the raw water from Cross Lake for the year 1959, as reported by the Shreveport Water Department. This water is suitable for municipal and most industrial uses after the treatment presently provided by the city.

Table 14 ^{12/}

Characteristics of Cross Lake Water
1959

	Quantity		
	<u>Maximum</u>	<u>Minimum</u>	<u>Average</u>
Turbidity (ppm)	24	12	18
Color (ppm)	37	16	28
pH	7.0	6.8	6.9
Total Alkalinity (ppm) as CaCO ₃	32	18	24
Total Hardness (ppm) as CaCO ₃	50	32	40
Total Dissolved Solids (ppm)	143	111	124
Chlorides (ppm)	108	50	84

Prior to 1959, Bossier City was dependent on Shreveport for its water supply. However, in that year, the city constructed and began operation of its own water treatment facility utilizing the Red River as a source. The flow of the Red River is sufficient to meet the water demands of Bossier City and after a high degree of treatment becomes satisfactory for domestic consumption except for short periods of time when its chemical characteristics exceed the recommended U. S. Public Health Service Drinking Water Standards, 1946 ^{16/}. Table 15 ^{16,17/} shows the weighted averages of sulfates, chlorides, and total dissolved solids along with the average discharge for the water years* of 1956 and 1957. These values are compared with the upper limits of the recommended U. S. Public Health Service standards. ^{16/}

*October, 1955 through September, 1957.

Table 15 16,17/

Chemical Characteristics of Red River Water at
Shreveport, Louisiana, 1956, 1957*

	Average Discharge (cfs)	Sulfates			Chlorides			Total Dissolved Solids		
		Weighted ppm	Avg. Tons/day	Max. ppm	Min. ppm	Weighted ppm	Avg. Tons/day	Max. ppm	Min. ppm	Max. ppm
1956*	11,600	102	3,200	281	24	139	4,350	410	29	512
1957*	40,800	54	6,000	283	14	71	7,830	410	16	287
Data Average	26,200	65	-----	283	14	86	-----	410	16	336
U.S. Public Health Service	-----	---	-----	250	--	---	-----	250	--	---
										1,000

*Water year October through September.

At present, this water is being treated by coagulation using ferric and ferrous sulfate, softening using the lime-soda process, stabilization by recarbonation, filtration by rapid sand filters and chlorination. Because of the wide range of chemical characteristics and silt load and the rapid rates of change of these qualities, very close attention to chemical dosage and detention time is required to effect a smooth transition and not change the quality of the finished water. Present costs directly attributable to treatment are approximately \$0.10 per 1,000 gallons or \$77,000 per year.

The town of Benton obtains its water from wells in the Wilcox sand which underlies most of the area. Table 16 shows a chemical analysis of the water taken by the Louisiana State Board of Health on June 30, 1953, from the city's newest well.

Table 16 18/

Characteristics of Well Water
Benton, Louisiana, June 30, 1953

Turbidity (ppm)	45.8
Color (ppm)	69
Total Solids (ppm)	1,411
Total Alkalinity (ppm) as CaCO ₃	582.1
Hardness (ppm) as CaCO ₃	20.3
Chlorides (ppm) as Cl	426.5
Iron, Total (ppm)	2.4
Fluorides (ppm) as F	3.1

In the above table, the high concentration of total solids, bicarbonate alkalinity, and chlorides stand out as being undesirable characteristics of the water. Also, the quantity of the water is limited due to the poor transmissibility of the aquifer. Present facilities are capable of producing approximately 0.4 mgd from three wells.

Additional Water Needs

Municipal and Industrial

The potential need for new sources of water in the study area is due primarily to considerations of quality, rather than quantity. Red River water is plentiful and readily accessible and only its poor quality makes it undesirable. Concerted efforts are being made to reduce pollution of the river from both natural and man-made sources. Nevertheless, tributary impoundments continue to be the favored sources for municipal and industrial water supply, wherever feasible.

Existing and prospective tributary impoundments, on the west side of the Red River, can supply the needs of Shreveport (including Barksdale Air Force Base) throughout the 50-year projection period. It is believed that the wells of the town of Plain Dealing will continue to produce water of good quality and that additional demands will be supplied from the storage available in Soil Conservation Service reservoirs. This leaves Bossier City and Benton as potential demand centers for water stored in the Cypress Bayou Reservoir.

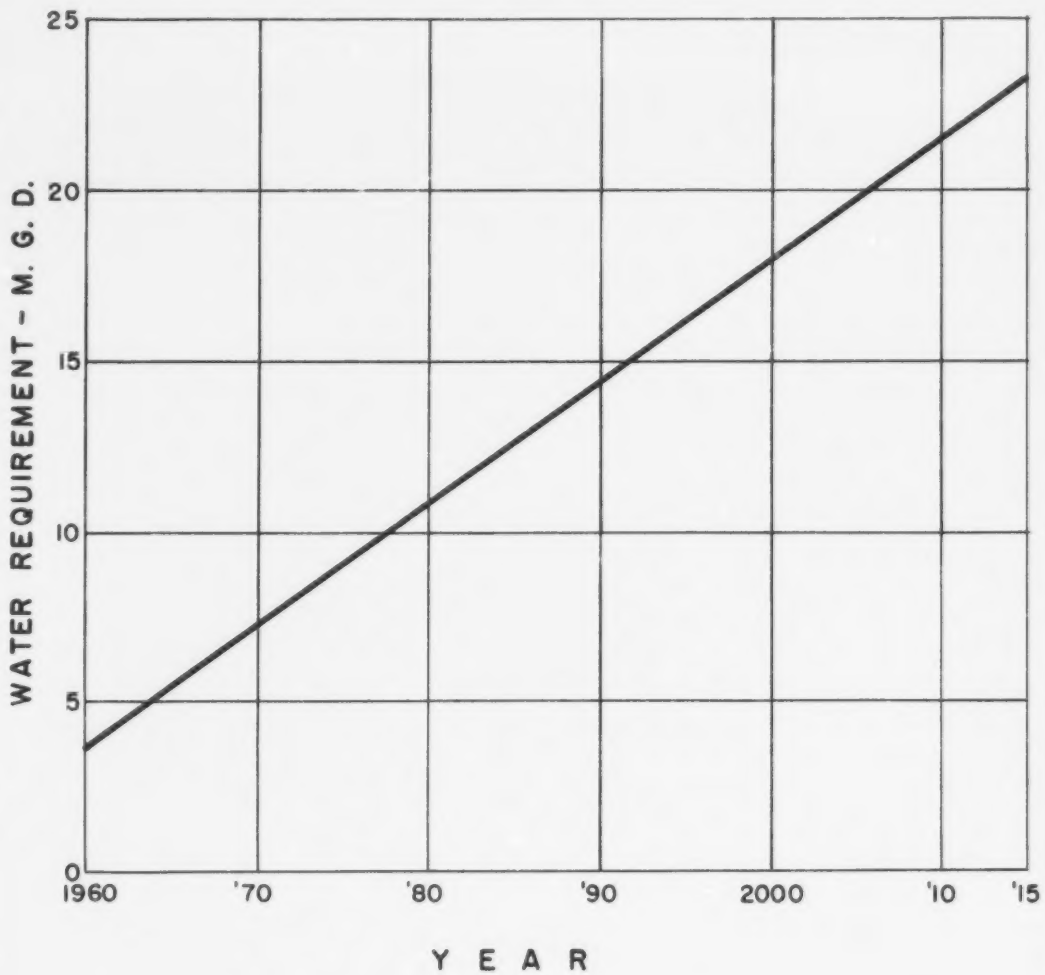
Total projected water demand, for Bossier City and Benton combined, is 23.4 mgd in the year 2015. This figure includes both municipal and industrial water and is equal to the product of projected population times a per capita use factor of 160 gallons per day. This factor is intended to represent the quantity of source water required and, therefore, to include distribution system losses, unaccounted-for water, and treatment plant attenuation.

The factor of 160 gallons per capita per day incorporates all of the water uses in a typical municipality which may reasonably be related to population -- including residential, commercial, public, and light industrial. Its adoption is based on judgment, taking into account the annual rainfall, which has been found to influence the per capita consumption, the characteristics of the demand area, and the expected nature of water using activities. Bossier City is a satellite community to the Shreveport metropolitan complex. As such, it is expected to have a normal share of commercial and industrial activities, but no significant development of large water using industries is forecast.

If the quality of the Red River is not improved either locally by upland storage and dilution, or at the source of the pollution, it is probable that the Cypress Bayou Reservoir would, in the course of time, supplant it entirely as the source of water for Bossier City. The same is true of Benton, because of both the poor quality and limited yield of the ground water source. Therefore, there is need for storage in the project to yield about 23.4 mgd. The projected water requirement is shown graphically in Figure 3.

Stream Quality Maintenance

Protection of the quality of Louisiana waters is primarily the responsibility of the Louisiana Stream Control Commission through the State Board of Health and the Division of Water Pollution Control of the Louisiana Wildlife and Fisheries Commission. Stream quality criteria and subsequent regulations governing waste discharges and other pronouncements on the maintenance of water quality within the



WATER RESOURCE STUDY
CYPRESS BAYOU RESERVOIR

PROJECTED M. & I. WATER
REQUIREMENT

DEPARTMENT OF HEALTH, EDUCATION & WELFARE

PUBLIC HEALTH SERVICE

REGION VII

DALLAS, TEXAS

MK

FIGURE 3

Louisiana boundaries come from these agencies. It is essential that recognition be given to the need for flows which must be maintained in the receiving stream if the quality of its waters is to be kept at reasonable levels. Estimates of these stream flow needs have been made, which indicate that the Red River has sufficient capacity to assimilate the projected waste flows of the study area after they undergo a reasonable degree of treatment without significantly lowering its quality.

The cities of Shreveport and Bossier City and the town of Benton discharge their wastes directly into the Red River. The town of Plain Dealing discharges its wastes into Cypress Bayou after treatment in an Imhoff Tank.

In addition, the use of salt domes for storage of natural gas under low pressure has recently increased in the study area. Continued adequate disposal of any wastes resulting from this activity is necessary to maintain stream quality.

VII. BENEFITS OF STORAGE

Evaluation Method

The 1958 report 13/ of the Subcommittee of Evaluation Standards states:

"From an over-all public viewpoint, a municipal and industrial water supply development will be economically justified if it provides water to meet expected needs at a cost not greater than the cost of the alternative source that would likely be utilized in the absence of the project."

Alternative Plan

The Red River was adopted as the alternative plan. A single-purpose reservoir at the site of the proposed multipurpose project was also considered but rejected after a cost comparison with the Red River water. The calculations for the costs of providing Red River water to meet the demands of the study area are shown in Exhibit A, and similar calculations for the single-purpose reservoir are shown in Exhibit B. On this basis, the annual benefits attributable to the project for a yield of 23.4 mgd are \$86,400 at site "C" and \$104,200 at site "A."

For converting capital costs to equivalent annual costs, an economically useful life of fifty years and a non-Federal interest rate of 4 per cent were assumed.

VIII. APPENDIX

EXHIBIT A-1

Calculations Used for Alternative
Cost Determinations

Alternative A - Red River

Assume:

1. No appreciable change in characteristics of Red River water for the duration of the projection period.
2. That the U. S. Public Health Service's recommended limit for chlorides is exceeded 90 days per year. (The 1954 data show chloride greater than 250 ppm for 87 days.)
3. That upland storage reservoirs will be constructed to provide good quality water collected from the river during periods of low mineralization. This water would be used to dilute the Red River water during high chloride periods and make it acceptable.
4. That one-half of the water demand during high chloride periods will come from upland storage and the reservoirs will be constructed in two increments in step with demand.

Then:

1. One-half water demand = $23.4 \div 2 = 11.7$ mgd.
 $11.7 \text{ mgd} \times 90 \text{ days} = 1,053 \text{ mg} = 3,230 \text{ acre-feet}$.
Make reservoirs 30 feet deep.
 $\therefore$ Surface area = 108 acres or two reservoirs
54 acres each.
2. Balance excavations and backfill to minimize costs. Using a trapezoidal dam section ten feet wide with 2:1 side slopes and excavating five feet, the reservoirs become 2,000 feet x 1,175 feet x 30 feet each.
3. Line reservoir with Gunite or equal to prevent seepage.
4. Fence area with four strand barbed wire.

EXHIBIT A-2

5. Total land cost to be allocated to the first reservoir.
6. From Figure 3 construct reservoir No. 1 in 1965 and reservoir No. 2 in 1982.

Summarizing:

Reservoir No. 1 - 1965

Land	125 Acre	\$250.00	\$ 31,250
Clear and grub	60 Acre	125.00	7,500
Excavation	438,000 c.y.	1.00	438,000
Backfill	397,000 c.y.	0.50	198,500
Guniting lining	104,000 s.y.	2.00	208,000
Fence	7,500 l.f.	0.50	3,750
Subtotal			<u>\$887,000</u>
Engineering and contingencies			89,000
TOTAL			<u>\$976,000</u>

Reservoir No. 2 - 1982

Clear and grub	65 Acre	\$125.00	\$ 8,125
Excavation	438,000 c.y.	1.00	438,000
Backfill	397,000 c.y.	0.50	198,500
Guniting lining	104,000 s.y.	2.00	208,000
Fence	4,000 l.f.	0.50	2,000
Subtotal			<u>\$854,625</u>
Engineering and contingencies			86,475
TOTAL			<u>\$941,000</u>

In the case of the project, a terminal reservoir would be immediately required (1965). The following assumptions are made in order to arrive at an estimate of the size required.

1. Terminal storage would be required during 100 days of the summer when demand is assumed to be 120 per cent of the average.
2. Average rainfall during 100-day summer period is 4 inches per month.
3. Average temperature during 100-day summer period is 80° F.

EXHIBIT A-3

Storage required = 20 per cent of average daily demand +
evaporation storage.
= $23.4 \text{ mgd} \times 0.20 \times 100 = 468 \text{ mg.}$
= 1,436 acre-feet.

Assuming 30 foot depth, surface area = 48 acres.
Evaporation $\frac{19}{12}$ = 40 inches for summer one-half of year.
100 day evaporation = $40 \times 100/180 = 22$ inches.
 $\therefore$ Evaporation storage = $22/12 \times 48 = 88$ acre-feet.
Total storage required = $1,436 + 88 = 1,524$ acre-feet.

The terminal reservoir is assumed to be similar to upland storage reservoir No. 1. Prorating cost for size:

Total cost = $\$976,000 \times 1,524 \div 1,615 = \$920,000.$
Benefits attributable to the project = $\$976,000 - \$920,000 = \$56,000.$

Reservoir No. 2 - 1982

Annual capital cost (amortize 50 yr. @ 4 per cent)	\$43,800
Estimated annual operation and maintenance	<u>2,700</u>
Total annual cost	\$46,500
Discounting to reference year 1965 @ 4 per cent	
Total annual benefits in 1965	\$23,900

Difference reservoir No. 1 and terminal storage for project.

Annual capital cost (amortize 50 yr. @ 4 per cent)	<u>\$ 2,600</u>
Total annual terminal storage cost	\$26,500

Treatment:

Cost of chemicals to treat Red River at present are 4.4¢ per 1,000 gallons. $\frac{12}{12}$ It is assumed that chemical costs for the project water would be one-half or 2.2¢ per 1,000 gallons. This then leaves a differential of 2.2¢ per 1,000 gallons attributable to the Red River.

1965 - 11.7 mgd	
$0.022 \times 11,700,000 \times 365 \div 1,000 =$	\$94,000 per year
1982 - 11.7 mgd	
$0.022 \times 11,700,000 \times 365 \div 1,000 =$	\$94,000 per year
Discount to 1965 @ 4 per cent	<u>48,300</u> per year
Total annual adjustment for difference	
in treatment costs in 1965	\$142,300

EXHIBIT A-4

Transmission:

It is assumed that transmission will be level and that a differential distance of 9 miles and 7 miles exists between the project sites "C" and "A" respectively and the Red River. The adjustment in this case is negative.

Construct parallel pipelines each with a capacity of 11.7 mgd, the first in 1965 and the second in 1982. Reinforced concrete cylinder pipe and an electric energy cost of 1.2¢ per kwh to overcome friction loss in pumping are assumed. For simplicity, the following assumptions are made:

1. Pumps will be single speed centrifugal.
2. One unit will be installed in 1965 and a second of equal size and type will be installed in 1982.

Comparison of cost of various pipe sizes showed a 30-inch pipe to be most economical in all cases. On this basis, system curves were developed for both sites as shown in Figure A-1. Pump characteristic curves of commercially available units were plotted on the same figure to find the operating points for the several combinations of head and flow. Pumps chosen exhibited a wire-to-water efficiency of at least 75 per cent throughout the operating range and for simplifying the calculations, the efficiency curve is assumed constant at 75 per cent for all cases. The following summarizes transmission costs. Energy costs were plotted for values calculated in step with the demand curve of Figure 3.

EXHIBIT A-5

	<u>Site "C"</u>	<u>Site "A"</u>
1965 to 1982, 1 - 30-inch pipeline, flow varies from 5.4 mgd to 11.7 mgd		
Annual Capital Cost	\$ 40,100	\$ 31,200
Annual Energy Cost	<u>7,900</u>	<u>6,400</u>
Total Annual Cost	\$ 48,000	\$ 37,600
1982 to 2010, 2 - 30-inch pipelines, flow varies from 11.7 mgd to 23.4 mgd		
1965 Annual Capital Cost	\$ 22,300	\$ 17,300
1965 Annual Energy Cost	<u>12,100</u>	<u>9,700</u>
Total Annual Cost	\$ 34,400	\$ 27,000
Negative Adjustment for Transmission	\$ 82,400	\$ 64,600
<u>Summary:</u>		
Terminal Storage Cost	\$ 26,500	\$ 26,500
Treatment Adjustment	<u>142,300</u>	<u>142,300</u>
Subtotal	\$168,800	\$168,800
Less Transmission Adjustment	<u>82,400</u>	<u>64,600</u>
Annual Value of Storage	\$ 86,400	\$104,200
	or 1.0¢	or 1.2¢
	per 1000	per 1000
	gallons	gallons

EXHIBIT B

Calculations Used for Alternative
Cost Determinations

Alternative B - Single-purpose Reservoir
At Cypress Bayou Reservoir Site

Assume:

1. Silt load -- 0.8 acre-feet/yr. sq. mi.
2. Sixty per cent of gross silt load is retained.
3. Required yield = 23.4 mgd in the year 2015.

From pertinent data:

1. Yield from 50,000 acre-feet = 23.4 mgd.
2. Drainage area = 147 sq. mi.
Therefore sediment storage =
(147) (0.8) (50) (0.60) = 3,500 acres
Total storage required 58,500 acre-feet

From cost-capacity curve: 14/

Estimated unit cost = \$98/acre-foot	
Estimated total cost = \$98 (58,500) = \$5,733,000	
Annual cost (50 years at 4 per cent)	
Annual storage cost = (5,733,000) (0.04655) =	\$266,900
Estimated annual operation & maintenance cost =	40,000
Total annual storage cost	\$306,900
	or 3.6¢
	per 1000
	gallons

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